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ABSTRACT

This study examined the nature, causes, and reinforcement of mathematics anxiety as well as methods of alleviating at least some of its symptoms. The literature on the subject was reviewed and an annotated bibliography prepared with entries grouped under three headings: (1) What is Mathematics Anxiety? Definition, Characteristics, and Symptoms; (2) What Causes Mathematics Anxiety and How is it Reinforced? Causes and Accentuating Factors; and (3) Is There Hope? Alleviating and Decreasing Mathematics Anxiety. Following the bibliography (which makes up a major portion of the document), a summary of findings for each of the three areas is presented. Findings show that mathematics anxiety is a mental, emotional, and sometimes physical disorder that can severely handicap the person who contracts it. Among its causes are teachers who are not skillful in mathematics (and may suffer from mathematics anxiety themselves) and the abstractness, symbolism, and rules of mathematics. Recommendations based on these and other findings are to help teachers cope with their own anxieties about mathematics, to create relaxed and supportive classroom atmospheres, to integrate mathematics into different subjects areas, and to dispell the "math mind" myths, sex-role stereotypes, and other stigmas that cause mathematics anxiety. (JN)

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AN ANNOTATED BIBLIOGRAPHY OF THE LITERATURE DEALING WITH MATHEMATICS ANXIETY

by

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INTRODUCTION

Over the past 30 years and especially during the past 15, much attention has been focused on the inability of many students to grasp mathematics. Many otherwise capable students struggle to understand mathematics while some do not even begin to master it.

Undoubtably mathematics will play a role in everyone's life, some to a greater and some to a lesser extent. It cannot be denied, however, that each of us will need it at some point in our lives. Therefore, it is essential that every obstacle possible be removed so that everyone will be able to learn mathematics to the best of his or her capabilities.

One major obstacle facing many people is the feeling of tension and stress that interferes with the solving of mathematical problems in academic and daily life situations, known as mathematics anxiety. (Streim 1981:3) This panic and mental disorganization arises in some people when they are confronted with a mathematical problem. (Sachs 1982:9) The public, especially educators, must be informed about this condition and learn ways of coping with and alleviating it.

STATEMENT OF THE PROBLEM

Almost all studies on mathematics anxiety have agreed that environment

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has some influence on a person's mathematical ability and interest. (Bulmahn 1982:55) Even so, a variety of causes still exist in this environment that continue to impede mathematics learning. (Nielsen 1979: 52 and Georgia State Department of Education 1982:80)

PURPOSE OF THE STUDY

Teachers, mathematics itself, and society in general (including the home) make up the environment in which a student learns mathematics. (Wagner 1980:58) Each influences a learner in its own way and yet in different ways for each individual learner. The abstractness and symbols of mathematics need to be explained but more importantly students must be informed of the relevance of the mathematics. (Brush 1981:38) Society must be made aware of its stigmas and stereotyping, then steps to change them need to be taken. Teachers, probably the single most important influence in a learner's environment according to Bulmahn (1982:55), must be able to contain and overcome their own anxieties as well as those of their students; thus opening the way to a better understanding of mathematics. (Wagner 1980:59)

ORGANIZATION OF THE STUDY

Before discussing possible cures for mathematics anxiety and methods of alleviating at least some of its symptoms it is first necessary to address two important questions. (1) What is mathematics anxiety? (2) What causes mathematics anxiety and how is it reinforced?

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The initial portion of the paper, definition, characteristics and symptoms, will address the former question. The latter question will

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be addressed in the second section of the paper, causes and accentuating factors.

After both of these questions have been answered the remaining portion of the research will be devoted to investigating methods of decreasing if not alleviating mathematics anxiety. The summary of this study will conclude with a recommendation of a strategy for meeting this end.

Within each section of the study annotations are arranged in alphabetical order according to the last name of the authors. They were arranged in this manner so as to not give proclivity to one idea over another.

LIMITATIONS OF THE STUDY

This study was limited to research in the area of mathematics anxiety completed in the past 10 years (with one exception). There was an adequate supply of material available, however, it was not in abundance. Much of it was opinion whereas research in the area was a bit more limited. Time limitations restricted an investigation of all the related information. It is believed, however, that further study of current data would not change the findings presented in this paper.

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GLOSSARY

anxiety-- "the tension that has no apparent cause." (Lasher 1981:3)

anxiety management training-- "the process of training students to relax in response to imaginary scenes which previously had been anxiety evoking." (Streim 1981:4)

Attribution Theory-- "according to this theory the four categories of reasons for success or failure are ability, effort, task difficulty and luck." (Wolleat 1980:356)

constructive floundering-- "learning what to do when you don't know what to do." (Tobias 1980:28GE)

dyscalcula-- "the inability to use numbers." (Chisholm 1980:22)

effectance motivation-- "a problem solving attitude inferred from behavior that shows an exploratory attitude and ranges from the lack of involvement to the seeking of the challenge." (Chisholm 1980:21)

emotionality-- "physiological and affective arousal." (Morris, L. 1978:590)

mathematics anxiety-- "irrational dread of math that disrupts the manipulating of numbers and solving of math problems within a variety of everyday life and academic situations." (Buckley 1982:1)

mathaphobia-- "irrational fear of mathematics." (Robertson 1983:5)

math avoidance-- "the failure of many to take more than just a minimum of mathematics classes." (Wolleat 1980:356)

math clinic-- "place where people can bring their personal learning problems with mathematics and seek remediation coupled with personal counseling and support." (Tobias 1978:8)

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mathemaphobia-- phrase coined by Gough (1954) but given no definition, used as the forerunner of the words mathaphobia and mathophobia.

mathematical self-concept-- "the beliefs and feelings or attitudes regarding a person's ability to understand or perform situations involving mathematics." (Gourgey 1982:5)

mathophobia-- "fear of mathematics that impedes people in the course of their lives." (Brocklehurst 1979:22)

negative practice-- "the process which involves repeated evocation of anxiety responses through the use of imagery stimuli." (Streim 1981:5)

self-instruction training-- "a process intended to reduce anxiety and increase self control." (Genshaft 1982:33)

worry-- "cognitive concern about test performance." (Morris, L. 1978:590)

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ANNOTATIONS

WHAT IS MATHEMATICS ANXIETY?
DEFINITION, CHARACTERISTICS AND SYMPTOMS

Buckley, Patricia A., Ribordy, Sheila C. "Mathematics Anxiety and the Effects of Evaluative Instructions on Math Performance." Paper presented at the Midwestern Psychological Association (Minneapolis, MN, May 6-8, 1982).

Mathematics Anxiety was defined as the irrational dread of math that disrupts the manipulating of numbers and solving of math problems within a variety of everyday life and academic situations. The study showed that high levels of mathematics anxiety had a debilitating effect in math test performance. It also showed that mathematics anxiety is different from test anxiety in that it is less affected by evaluative and/or reassuring instructions. The study also pointed out that mathematics anxiety is a reaction to math content in addition to math tests. Finally the study showed that sex role identification was not found to relate significantly to mathematics anxiety.

Dew, Kathleen Michie Harriss, Galassi, John P. "Mathematics Anxiety: Some Basic Issues." Journal of Counseling Psychology. 1983. 30: 443-6.

Dew and Galassi conducted a study with college students to further investigate the relationship between test anxiety and math anxiety and the prevalence of math anxiety in men and women. Previous studies had either shown a relationship between the two or have viewed math anxiety as a form of test anxiety.

Three tests (Fennema and Sherman's Mathematics Anxiety Scale, Sandman's Anxiety Toward Mathematics Scale, and Suinn's Mathematics Anxiety Rating Scale) were used to measure mathematics anxiety and test anxiety was measured by Spielberger's Test Anxiety Inventory.

It was concluded that there may be gender differences in mathematics anxiety but that they are probably much smaller than had previously been suggested. It was also concluded that test and math anxiety are related but they do not seem to be interchangeable, nor are they synonymous.

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Gough, Sister Mary Fides, O.P. "Mathemaphobia: Causes and Treatments." The Clearing House, Jan. 1954. 28: 290-94.

Gough was the first to coin the phrase mathemaphobia but said that it needed no explanation. She hinted that it meant the dislike or fear of math or the fear of failure in math. She did not explain any causes of or treatments for mathemaphobia.

Morris, Larry W., Kellaway, Dale, S., Smith, Donna H. "Mathematics Anxiety Rating Scale: Predicting Anxiety Experiences and Academic Performance in Two Groups of Students." Journal of Education Psychology. Aug. 1978. 70: 589-594.

Equal numbers of psychology and mathematics students were administered the Mathematics Anxiety Rating Scale (MARS). Emotionality (physiological and affective arousal) and worry (cognitive concern about test performance) were also assessed. The purpose of the study was to compare these three variables, determine their relationship to each other, and to compare the results between the two types of students.

Several results were determined. Firstly, it was found that emotionality had no effect on test performance. There was, however, a strong correlation for both groups between MARS and worry scores. No significant sex differences were determined on any of the tests.

The significant positive relationships among MARS and the other two scores suggested that MARS scores could be used as valid predictors of test anxiety. Results also indicated that the anxiety variable with the strongest effect on academic performance was worry. Worry scores were related inversely to test performance in both groups.

Robertson, Douglas F., Claesgens, Joan. "Math Anxiety-Causes and Solutions." Paper presented at the Minnesota Vocational Summer Conference of the Area Vocational-Technical Institutes (Minneapolis, MN. Aug. 11, 1983).

Robertson defined mathaphobia as the irrational fear of mathematics, and used it synonymously with mathematics anxiety. He described four characteristics of them: (1) intense emotional reactions to numbers, (2) avoidance of mathematics, (3) poor preparation in mathematics, (4) test anxiety.

He developed for the Continuing Education for Women Program (CEW) a math anxiety program which was successful in assessing math abilities, improving math skills, and improving attitudes towards math. The 4 parts of this program are the diagnostic clinic, the support group, mathematics tutoring and math courses.

There were also 4 major points which were used when teaching students that had math anxiety. Firstly, students had to be helped to feel good about themselves. Success breeds satisfaction and excitement. Secondly, the teachers needed to possess truly positive attitudes towards students and the subject. Thirdly, adults were encouraged to use calculators and lastly, students and teachers had to have fun with math and with each other.

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Rounds, James B., Jr., and Hendel, Darwin D. "Measurement and Dimensionality of Mathematic Anxiety." Journal of Counseling Psychology. 1980. 127: 138-149.

The study conducted by Rounds and Hendel indentified 2 distinct factors (Mathematics Test Anxiety and Numerical Anxiety) that were involved when using the MARS (Mathematics Anxiety Rating Scale). This contradicts the statements of Richardson and Suinn (1972) which stated that MARS was a unidimensional construct. The study suggested that MARS measured anxiety primarily as test anxiety and secondly as anxiety related with mathematics courses and not as anxiety about everyday numerical manipulation.

The results indicated that mathematics anxiety is more a response to mathematical skills evaluation than it was to mathematics. The results further pointed out that by itself math anxiety determined by MARS provided little useful information and that to be useful it must be combined with the Mathematics Test Anxiety Scale and the Numerical Anxiety Scale. The three of them together would provide the information needed in assessing a person's needs and developing a program to help that person.

Sachs, Steven Mark. "A Refinement of the Relationship Between Examination Performance and Mathematics Test Anxiety." March 1982. Nova University.

Mathematics Anxiety was defined as feelings of tension that interfere with the manipulations of numbers and the solving of mathematical problems. It was also described as the panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem.

This study revealed correlations between: (1) high entering math scores and low mathematics anxiety (and between high anxiety and low test scores), (2) entering math scores and midterm exam scores, and (3) student mathematics anxiety level and math test performance. The study also pointed out that teachers play an important role in the development of mathematics anxiety. Often students have developed mathematics anxiety because they have been embarrassed by a teacher.

The study ends with the recommendation that Math Anxiety Reduction Programs be implemented at all educational levels.

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Widmer, Connie Carroll, Chavez, Annette. "Math Anxiety and Elementary School Teachers." Education. Spring 1982. 102: 272-6.

This study investigated the presence of math anxiety in elementary school teachers in relationship to perceived types of training, career inhibitions, recency of training and sex. No relationship was found between math anxiety and sex or recency of training.

It was found that subjects who were math anxious inhibited career goals more than those who weren't. It was also found that those teachers who perceived their mathematics education as having stressed computation were much more likely to become math anxious than were those whose mathematics education was perceived as stressing understanding.

It was recommended that the presence of a supportive teacher and a healthy classroom were essential for fostering positive attitudes towards mathematics. Also, by emphasizing understanding rather than computation math anxiety can be reduced.

Wolleat, P. L., and others. "Sex Differences in High School Students' Causal Attributions of Performance in Mathematics." Journal for Research in Mathematics Education. Nov. 1980. 11: 356-66.

'Math Avoidance' is the term used to describe the failure of many to take more than just a minimum of mathematics classes. Wolleat did a study in 1978 of 600 male and 600 female high school students to see if the principles of attribution theory could be used to explain this phenomena. According to this theory there are 4 categories of reasons for success or failure. These are ability, effort (internal), task difficulty and luck (external). Of these, ability and task performance are considered stable factors while effort and luck are unstable factors.

The results showed that males tended to attribute success to ability and females to effort. The higher the performance level the more profound the difference. On the other end of the scale females tended to attribute failure more to the lack of ability and task difficulty than did males.

The study point[illegible] out that females are less confident than males in their ability to learn mathematics and that this may be caused by the attributional patterns they have learned to use.

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WHAT CAUSES MATHEMATICS ANXIETY AND HOW IS IT REINFORCED? CAUSES AND ACCENTUATING FACTORS

Brocklehurst, Nancy. "Women and Math: Overcoming Avoidance." College Board Review. Spring 1979. 111: 22-44+.

Brocklehurst reviewed the research on mathematics anxiety and women and quoted Mitchell Lazarus, senior staff associate at Education Development Center in Newton, Massachusetts and author of several papers on the subject, who defined "mathophobia" as the "fear of mathematics that impedes people in the course of their lives." She further pointed out that this affected women and minorities more than men.

Brocklehurst cited research that had shown that women scored lower than men on both the math sections of the SAT and on Achievement Tests. Tests to determine biological causes for this difference were inconclusive, but strong arguments were offered for a cause being the influence of cultural conditioning.

Research showed that girls kept pace with boys in mathematics until age 13. After that boys excelled. Possible explanations were the influence of hormones, extracurricular learning that boys had which girls did not, and more intensified sex-role socialization. Much of the problem came also from the failure of the adults who taught the children (both parents and teachers) to get the information across.

Brush, Loreiei R. "Some Thoughts for Teachers on Mathematics Anxiety." Arithmetic Teacher. Dec. 1981. 29: 37-9.

The Mathematics Anxiety Rating Scale (MARS) constructed by Suinn and Richardson is one of the best available sources for testing math anxiety. A person taking the test is asked to put him or herself in different situations (94 of them) and imagine his or her reaction.

The questions are of 2 basic types: calculations and evaluation by others. The calculation part causes little anxiety in the students even though many have a strong dislike for it. The part that does cause anxiety is the waiting, test preparation and other situations that may cause a student to be put on the spot.

At sixth grade and earlier math causes little anxiety in students but as it becomes more abstract, less life-orientated and more impersonal, it causes more and more anxiety. English on the other hand causes a lot of anxiety through sixth grade but through high school the subject seems to get easier and less likely to cause anxiety.

Teachers can ease or lessen the anxieties caused by math, by explaining in the clearest manner, easing into new topics, and by being open for and inviting questions. Teachers can further help by getting away from using the textbook all the time and including issues that involve human interest or at least relate to their students' lives.

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Bulmahn, Barbara J., Young, David M. "On the Transmission of Mathematics Anxiety." Arithmetic Teacher. Nov. 1982. 30: 55-6.

Almost all studies conducted on math anxiety agreed that environment has some effect on a person's mathematical ability and interest, and elementary teachers play an important part of any individual's early mathematical environment. A survey of over 200 first year college students, of which about half were prospective elementary school teachers, showed that there was a strong tendancy towards 'The Humanities' rather than 'The Sciences' in this half of the students.

It was the feeling of the majority of these students that elementary teachers didn't really have to be very good in math beyond basic computations. These students also had a real fear of word problems, and an overall lack of interest in math.

If math anxiety is a communicable disease then it is being past on by elementary teachers to generations of students. One possible 'cure' for this would be to provide elementary schools with mathematics specialists.

Chisholm, Carol. "Correlates of Math Avoidance Responsible for Filtering Individuals from Math/Science Areas." June 1980. Masters Thesis, Townson State University.

Research on over 500 subjects identified 7 reasons for mathematics avoidance. Originally it was hypothesized that mathematics anxiety would be the best predictor of math avoidance but this was found to be wrong because it could be lessened through clinical intervention. The 7 reasons follow in order of magnitude: (1) effectance motivation (a problem solving attitude inferred from behavior that shows an exploratory attitude and ranges from lack of involvement to the seeking of the challenge), (2) confidence in learning math (i.e. the more confident one is, the less likely one is to avoid math), (3) perceived usefulness (i.e. the more useful math is perceived to be the less it is avoided), (4) math anxiety (math anxiety ≠ math avoidance; regular use of math may result in lessened math anxiety), (5) father scale (the more positive the factors relating to one's father the less math avoidance), (6) interaction of sex and confidence in learning math. (females had less confidence than males), (7) other variables less significant (i.e. mother and teacher scales and dyscalcula; the inability to use numbers).

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Georgia State Department of Education. "Mathematics for Georgia Middle Grades." 1982.

The report prepared by the Georgia Office of Instructional Services stated that mathematics anxiety in students was caused by a variety of sources. The major sources included: (1) student readiness- teachers expect more than students are capable of doing, (2) teacher math anxiety- relayed to the student, (3) language- the more reading involved the harder it may be, (4) motivation- students had attitude that mathematics was dumb, (5) home- students can't study at home for various reasons, (6) stereotyping- girls not as capable as boys. The report also suggested some possible solutions for at least lessening mathematics anxiety. (1) Open discussion- get it in the open and let students know that the teacher is aware and concerned. (2) Teachers should increase motivation and enthusiasm. The report did not give suggestions as how in fact to increase motivation and enthusiasm.

Hartshorn, David. "Cause for Anxiety." The Times Educational Supplement. 1982. 3460: 43-4.

Hartshorn proposed several possible causes of mathematics anxiety. One of these was that children require instant gratification, and they can hardly be motivated in something in which their parents often had no success and in which they feel they have no hope for success.

A second, even more serious cause is that many lower grade level teachers are not skillful in math. They tend not to enjoy math themselves and lack confidence, and this attitude is easily conveyed to the students. One last cause of mathematics anxiety, possibly related to the second, was the structure of the methods that students were required to use. Right answers were emphasized and not the right methods.

Merchant, Ronald. "Overcoming Math Avoidance Tendencies." Business Education Forum. 1983. 37: 3-6.

Lower math skills was the reason given for the differences in wages between many workers, especially between men and women. The most recent studies have shown that mathematics ability is not sex-linked. In fact, relative lack of competence resulted primarily because of sex-role expectations for females.

Anxiety about mathematics affected both males and females though. It was usually the result and not the cause of negative experiences with math. Merchant pointed out that teachers could help students overcome their anxiety by introducing them to electronic devices that can simplify the drudgery of doing math, once they had a strong foundation in the basics. He also pointed out the need for realistic practical problems.

Merchant emphasized that the single most important factor in motivating students is a teacher's own attitude towards them. A teacher should give students empathy not sympathy, recognition not fame, cooperation not power, and respect not prestige. Teachers need to treat students as equals.

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Nielsen, Linda. "Feminism and Factoral Analyses: Alleviating Students' Statistics Anxiety." College Student Journal. 1979. 13: 51-6.

Nielsen's research found that no differences exist between female and male math achievement or math anxiety (which she used synonymous with math phobia) until high school. She attributed the increase in female anxiety to the sex role stereotype that math is a masculine discipline, teachers' sexist expectations, sexist math curriculum, scarcity of female mathematicians as role models, lack of parental encouragement, and early failure experiences in math courses.

Nielsen's study also outlined 16 practices than could be helpful in alleviating mathematics anxiety (especially in females). These range from being humorous and personal to taking time for private conferences and expounding upon female contributions in math and math related fields.

Oberlin, Lynn. "How to Teach Children to Hate Mathematics." School of Science and Mathematics. March 1982. 82: 261.

When children start school they do not, in general, usually hate mathematics. Teachers help children develop this hate by using one or more of the following procedures. (1) Assign same work to everyone. (2) Go through book, page by page, problem by problem. (3) Assign written work everyday. (4) Assign a lot of homework. (5) Never correlate math to real life. (6) Insist there is only one way to solve a problem. (7) Assign math homework as a punishment. (8) Have all students complete all review work at front of book. (9) Assign a multitude of drill problems over the same thing. (10) Always insist papers are prepared a certain way. (11) Insist every wrong problem is reworked until it is correct.

Tobias, Sheila. "Managing Math Anxiety: A New Look at an Old Problem." Children Today. Sept-Oct 1978. 7: 7-9+.

Tobias' research concurred with others and showed that part of the reason for math anxiety in females is stereotyping. Many females avoid mathematics because they fear they will lose their femininity if they succeed.

Tobias' research showed math clinics, places where people can bring their personal learning problems with mathematics and seek remediation coupled with personal counseling and support, were successful in helping combat math anxiety. The main purpose of these clinics was to tune people into themselves and direct them in the process of dealing with their own math anxiety. Also, Tobias pointed out that math anxiety can never be eliminated but the whole point is to manage and control it.

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Wagner, Jennifer L. "Math Anxiety: Prevention and Cure." Curriculum Review. 1980. 19: 58-9.

Wagner stated that there were three primary factors contributing to math anxiety. Firstly, the mathematics itself, because it is abstract with a variety of symbols and rules. Secondly, society in general because of stereotyping and in some subcultures because of "good student" stigmas. Thirdly, teachers in particular, because math anxious teachers pass on their anxiety to their students, and because more often than not correct answers and not correct methods are emphasized.

Wagner pointed out that teachers must control or eliminate their own anxieties and they should emphasize reasoning, alternate methods, checking, and estimating, instead of the one and only one answer. Wagner also offers two cures for math anxiety once it has been contacted. First, the victim must experience success and second, the relevance of math must be made obvious.

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IS THERE HOPE?

ALLEVIATING AND DECREASING MATHEMATICS ANXIETY

Barrow, Rosemary. "Use of Personal Journals to Reduce Mathematics Anxiety." Journal of College Student Personnel. March 1984. 25: 170-1.

A large percent of college freshmen were underprepared to take traditional college math courses, and had to take developmental mathematics courses first. Many of these students had a fear of mathematics.

One strategy that was successfully used to reduce these fears and anxieties was the use of personal journals. By requiring students to write down their feelings, discoveries, progress, needs for help, satisfactions, frustrations and suggestions for changes in the operations of and methods used in the class a professor could encourage, reinforce and empathize.

Done on a weekly basis it also allowed professors to identify and then alleviate individual problem areas.

Chapline, Elaine Burns. "Formative Evaluation in the Development of a Math Anxiety Reduction Program." Paper presented at the annual meeting of the American Educational Research Association (Los Angeles, CA. April 13-17, 1981).

The Teacher Education and Mathematics Project, funded by the Women's Educational Equity Act, developed curriculum materials to increase math knowledge and confidence, increase the perception of math as a female domain, reduce math anxiety and develop skills in identifying and counteracting sex bias in math instruction.

For this program to work, Chapline pointed out that the teachers who use it must first be free of mathematics anxiety. She also pointed out that the materials did not have to be used exactly as prescribed but that is was best to interact with them and use them with a heightened sensitivity and awareness of student needs.

Chapline, Elaine B., and others. "Teacher Education and Mathematics Project. Final Report 1979-1980." 1980.

Chapline developed a model program and instructional materials used to increase confidence and skills of students in undergraduate teacher education courses. The program and materials were designed: (1) to reduce mathematics anxiety, (2) develop instructional skills in identifying sex bias in math materials and teacher-pupil interactions and, (3) increase teacher knowledge of mathematical concepts needed for elementary instruction.

Eighty percent of those students tested in this program felt that their mathematics anxiety was caused by some traumatic experience and 68% said it was caused by a teacher. The author claims the program was a success but had no figures to document it. She ended by saying more research was needed.

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DeBronac- Mead, Marie Louise, Brown, Ric. "Reduction of Mathematics Anxiety: A Cognitive Behavior Modification Approach." Paper presented at the annual meeting of the American Educational Research Association (New York, NY, March 19-23, 1982).

A study was conducted with two groups of students each with approximately the same level of mathematics anxiety. The study showed that there was a decrease in mathematics anxiety in the group that used a combination of behavior modification along with training in math skills and concepts. The study pointed out that children whose parents encouraged them were less anxious than others and that failure to encourage may be as negative as actual discouragement. The study also concurred with previous research which showed that the better the mother of a child was educated, the less mathematics anxiety that child would exhibit.

Furuto, David M., Lang, Melvin. "Relationship of Self Concept Enhancement to Anxiety and Achievement in College Mathematics." Paper presented at the annual meeting of the American Educational Research Association (New York, NY, March 18-23, 1982).

The purpose of Furuto's study was to determine if teaching strategies designed to help pupils build positive and realistic self concepts would affect attitudes, anxieties, and achievement in mathematics. The results of the study showed that there was a positive correlation between teacher attitudes and math achievement. The study also showed that behavior modification techniques improve attitudes toward mathematics and that mathematics anxiety was reduced by improving self-concept.

Genshaft, Judy. "The Use of Cognitive Behavior Therapy for Reducing Math Anxiety." School Psychology Review. Winter 1982. 11: 32-4.

A control group which went just to class, a second group which received tutoring and a third group which received self-instruction training as well as tutoring, of seventh grade girls were studied for differences in mathematical achievement. Self-instruction training which is a process intended to reduce anxiety and increase self control coupled with tutoring proved to be highly effective and promising. The findings suggested that teachers concentrate on developing expectations of mastery and success before feelings of failure and anxiety can develop.

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Gourgey, Annette F. "Development of a Scale for the Measurement of Self-Concept in Mathematics." 1982. New York University.

Past evidence has shown that people who have suffered from mathematics anxiety have also suffered from a poor self-concept in regard to their mathematical ability. This study showed that mathematical self-concept is only slightly related to mathematics anxiety. It was shown to be more closely related to arithmetic skills, acceptance of various mathematical beliefs and test performance.

The construct of the Mathematical Self-Concept Scale for this research was developed over a 3 year period and 3 mathematicians experienced in remediation of mathematics anxiety attested to the scales content validity. Mathematical self-concept was defined as the beliefs and feelings or attitudes regarding a person's ability to understand or perform situations involving mathematics.

The research showed that for remediation it is important to focus in on improving a student's mathematical self-concept. It was also suggested that mathematics self-concept may be a more powerful and more informative variable than mathematics anxiety.

Heller, Barbara R, Kogelman, Stanley. "Project MART (Mathematics Anxiety Reduction Training) III Encouraging the Dissemination and Use of Instructional Materials to Counteract Student Math Avoidance." Nov. 1982. Sponsored by the New York State Education Dept.

MART was a three phase project which sought to counsel teachers so that they would decrease their own contribution to mathematics anxiety. Phase I was a study of college students which found a correlation between mathematics anxiety and poor math preparation which interfered with achievement. The study found that faculty and staff needed a better understanding of mathematics anxiety and also that without adequate background in math, students' career options were restricted.

Phase II was the development of written materials that would help teachers alleviate mathematics anxiety in their classrooms. Finally, Phase III was the development of a program to train teachers to use the materials and help them find ways to encourage in-class solutions to alleviating mathematics anxiety.

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Hodges, Helene L. B. "Learning Styles: Rx for Mathophobia." Arithmetic Teacher. March 1983. 30: 17-20.

The fear of mathematics was a reality for many students. Their reactions ranged from anxiety, fear and frustration to avoidance and indifference. By shaping the 18 elements that affect learning styles to fit students' needs it is possible to increase students' success and decrease their anxieties.

The 18 elements are divided into four categories: environmental (time of day and room conditions), emotional (amount of structure, motivation and persistance needed), sociological (alone, small groups, large groups), and physical (perceptual strengths).

Each student responds differently to each stimuli so in order to prescribe the correct formula for success a teacher must, according to Dunn and Dunn 1978, know: "(1) the amount of structure that person needs, (2) her or his perceptual strengths, (3) the time of day when that person is most alert, and (4) her or his sociological preferences." (p.19)

Howard, Bessie C. "Mathematics in Content Areas. MICA. A Teacher Training Approach." Paper presented at annual conference of the Association of Teacher Educators (Phoenix, AZ. Feb. 14-17, 1982).

All teachers should have inservice instruction focusing on the uses of mathematics in specific content areas. Howard's research showed that mathematics anxiety and fear have reached epidemic proportions and the solution is to help students feel that math is enjoyable, valuable and fun. Inservice programs should be used so that math would be integrated into different subject areas thus showing students that math is valuable, and important.

Teachers transmit their anxieties as well as their excitement and values. Through MICA teachers would become more aware of the uses of mathematics and well as learn to lessen their own anxieties.

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Lasher, Ann M. "Combatting Math Anxiety While Building Basic Skills: There is Time for Both." Paper presented at the Conference on Remedial and Developmental Mathematics in College: Issues and Innovations (New York, NY, April 9-11, 1981).

Anxiety was defined as the tension that has no apparent cause. Mathematics anxiety was defined as the tension that interferes with mathematical performance and is not ability related to any apparent cause. Mathematics anxiety was also defined as the tension that blocks a student's learning process and as the block to skills acquisition.

To alleviate mathematics anxiety Lasher recommended that an instructor be positive and build a positive and relaxed classroom atmosphere. A teacher must adapt to the learning styles of the students in a particular classroom and must be able to bring and handle problems in the open.

Lasher suggested several ways to stimulate discussion about, and lessen mathematics anxiety. Two ideas were to have students keep a math autobiography (a catalog of personal and family math related experiences) and to have them make a list of math self talk (a series of positive and negative statements about math). She also suggested using math in disguise (in sports, the newspaper, etc.) and building a variety of math strategies.

Morris, Janet. "Math Anxiety: Teaching to avoid it." Mathematics Teacher. Sept 1981. 74: 413-17.

Math anxiety and general anxiety do not go hand in hand. A math-anxious person may in general not be an anxious person at all, or vice versa. Math anxiety is not related to general intelligence either; it often afflicts people who may be highly successful in other areas.

Morris found that all too often math anxiety was traced to a negative experience with mathematics during early school years. Her research developed a list of 9 strategies teachers can use to help prevent math anxiety among students. (1) Create a positive, supportive classroom atmosphere. (2) Stress understanding the thought process. (3) Dispel the "math mind" myth. (4) Provide new positive math experiences. (5) Use concrete materials to teach content at all levels. (6) Make sure each concept is understood before continuing. (7) Reduce tension and pressure in mathematics classes. (8) Give positive feed-back on written test. (9) Be sensitive but determined. Morris lastly pointed out that since anxiety is a learned response to a negative experience, it can be prevented.

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Richardson, Frank., Suinn, Richard M. "The Mathematics Anxiety Rating Scale: Psychometric Data." Journal of Counseling Psychology. 1972. 19: 551-554.

The Mathematics Anxiety Rating Scale (MARS) was limited in construction to measure only anxiety related to the use of a mathematical concepts and to the manipulation of numbers. This was done because evidence supports that scales in limited scope are better predictors of what they are trying to measure than those which are broad in scope. The instrument was found to have high test-retest and internal consistency reliability.

The scale could be used to test the effectiveness of a new mathematics anxiety reduction program or it could be used to test the mathematics anxiety level of an individual. It could be used as a tool in treatment as well as in research.

Sherard, Wade H. "Math Anxiety in the Classroom." The Clearing House. Nov 1981. 55: 106-110.

Sherard described math anxiety as an intense, negative emotional reaction to mathematics or the fear of mathematics. This anxiety can be so acute that some people will avoid mathematics at all costs, thus seriously limiting and handicapping themselves both in career opportunities but in their everyday lives as well.

Sherard's research produced the following procedures that can be used by teachers to help reduce mathematics anxiety. (1) Avoid sex role stereotyping of mathematics as a male domain. (2) Make students aware of the everyday usefulness of math, especially for life plans and careers. (3) Help students to develop self-confidence in their ability to do mathematics. (4) Concentrate especially on problem solving, spatial skills, and the language and symbolism of mathemtics as important aspects of the math curriculum. (5) Avoid teaching behavior which is inflexible or excessively authoritarian. (6) Be aware of possible negative effects that testing may have on mathematics attitudes and anxiety. (7) Avoid insensitive behaviors in teaching procedures. (8) Provide a relaxed, supportive classroom atmosphere. (9) Be aware of one's own feelings about mathematics and show students that you have an interest in and enthusiasm for mathematics.

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Stevens, Phyllis W. "Computer Programs to Reduce Math Anxiety." May 1982.

Twenty four computer programs were developed and tested. Of these 13 were tutorial in nature while the other 11 provided examples.

It was concluded that supplemental programs enhanced students' coping skills which in turn enabled them to turn negative emotions into constructive motivation. It was also suggested that it may not be good to eliminate math anxiety altogether, but rather channel it to energy. For some, this anxiety is a motivation.

Streim, Leonard, Obrien, Richard M. "The Relative Efficacy of Negative practice and Anxiety Management Training in the Treatment of Mathematics Anxiety." Paper presented at the annual meeting of the Eastern Psychological Association (New York, NY. April 22-25, 1981)

Mathematics anxiety involves feelings of tension and stress that interfere with the solving of mathematical problems in academic and daily life situations. Streim's study supported the hypothesis that anxiety management training and negative practice reduce mathematics anxiety and improve performance in math.

Anxiety management training is the process of training students to relax in response to imaginary scenes which previously had been anxiety evoking. Negative practice is the process which involves repeated evocation of anxiety responses through the use of imagery stimuli.

Though the study showed that both anxiety management training and negative practice reduce math anxiety and improve performance it did not show which, if either, of the two was more effective.

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Tobias, Shela. "Math Anxiety." Ms. 1976. 5: 56-94.

This article explains about the math clinic that Tobias set up at Wesleyan University. The clinic was set up in hopes of developing cures for the symptoms, if not the causes, of mathematics anxiety. The main goal of the clinic was to diagnose each individual and then develop and implement a plan of instructions that would best suit that person's own cognitive strengths and weaknesses.

Tobias, Sheila. "Math Anxiety: What You Can Do About It." Today's Education. Sept.- Oct. 1980. 69: 26-29.

The math clinic set up by Tobias at Wesleyan University used math autobiographies and personal interviews to get at the heart of an individual's math anxiety and to help overcome it. Tobias found the following factors influenced the development of mathematics anxiety: (1) mysteries and myths about math understanding being a 'gift', a male domain, and that good work in math is instantaneous, (2) inadequate out-of-class experience, (3) language, mathematics and mistaken meaning, (4) classroom stress.

She recommended that the following ideas be emphasized in mathematics classes in order to overcome the previously mentioned influences. (1) Reading mathematics. (2) Developing the spatial skills of visualization and orientation. (3) Developing the use of formal thinking and notation in dealing with abstractions. (4) Problem solving. (5) Constructive floundering- learning what to do when you don't know what to do.

Wood, Dorothy F. "The Fourth R-Wrong." Mathematics Teacher. Dec. 1982. 75: 728-30.

One cause of mathematics anxiety is the frustration and frequency of making errors. However, making mistakes in math is normal, but the consequences of these mistakes can be severe.

Wood recommended that this type of anxiety be confronted directly. It should not be treated lightly but talked about openly and honestly. Teachers and students must work together to minimize each others mistakes, and to relieve the anxiety.

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Wright Donald E., Miller, Loretta Diane. "Math Anxiety: A Research Report." Paper presented at the annual meeting of the Mid-South Educational Research Association (Lexington, KY. Nov. 1981).

This research was presented in 5 parts. (1) Math Anxiety: Real... and Complex; defined mathematics anxiety. (2) Math Anxiety and Middle School Students; showed that students at all levels were susceptible to mathematics anxiety. (3) Math Anxiety and College Freshman; pointed out that mathematics anxiety does exist in college to a high degree and it limits career availability but that there is, if not a cure, at least help. (4) Math Anxiety and Elementary Teachers; strongly supported the hypothesis that math anxiety may be initiated by elementary teachers. (5) Conclusions, Discussions, and Remedies, which are as follow. (A) Groups have little impact on a person's math anxiety. (B) People with math anxiety perceive that their math skills are less proficient than their other skills and they do not like math. (C) Motivation and successful math experiences are closely related to math anxiety and have a great impact on the successfull completion of math tasks. (D) Actual performance and teaching of a math skill, do not decrease math anxiety equally for all people. (E) Some mathematics anxiety is good. (F) Those with mathematics anxiety should seek help. (G) Mathematics reduction programs should be offered but from somewhere outside the math department.

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SUMMARY

Gough was one of the first people to write about the problem of mathematics anxiety. In 1953 she coined the phrase mathemaphobia but never really explained it. She hinted at its meaning but said that it did not need defining. Robertson used the phrase mathaphobia synonymously with mathematics anxiety and defined them as the irrational fear of mathematics. Both Buckley and Sachs expanded upon Robertson's definition and explained that mathematics anxiety is the tension (Sachs) or the irrational dread (Buckley) of math that disrupts the manipulation of numbers and the solving of mathematical problems.

Robertson described four basic characteristics of mathematics anxiety: (1) intense emotional reactions to numbers, (2) avoidance of mathematics, (3) poor mathematics background, (4) test anxiety. Sachs more dramatically described it as the panic, helplessness, paralysis and mental disorganization that arises in some people when they are required to solve a mathematical problem.

Rounds' research revealed that mathematics anxiety is not so much a reaction to mathematics itself as it is a reaction to mathematical skills evaluation. Sach's research concurred with this and further revealed that there exists a high inverse correlation between math scores and mathematics anxiety (high math scores= low mathematics anxiety, low test scores= high mathematics anxiety). Morris showed that worry, the variable with the strongest influence on academic performance, was also related

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inversely to test performance. He also demonstrated a strong correlation between worry and mathematics anxiety.

Bulmahn found that almost all studies on mathematics anxiety agree that environment has some effect on a person's mathematical ability and interest. Studies by the Georgia State Department of Education, Hartshorn, Merchant, and Wagner have all evinced that the elementary teacher, who is a major part of this environment, is a major cause of mathematics anxiety in many students. Hartshorn, Wagner, and the study by the Georgia State Department of Education revealed that elementary teachers, themselves, often possess mathematics anxiety and that this anxiety is transmitted to their students. Merchant also pointed out that mathematics anxiety could be the result and not the cause of negative experiences in mathematics.

Brush, the Georgia State Department of Education, Hartshorn, and Wagner also agreed that a second major cause of mathematics anxiety is the mathematics itself. Hartshorn and Wagner further explained that emphasis on only answers and not on methods was one major reason that this was so.

In addition to those reasons just mentioned, other causes exist which affect primarily females. Brockhurst's research to show biological causes was inconclusive, however she did show that cultural conditions played an extensive role in the development of mathematics anxiety in females. Nielsen, Tobias, Wagner, and the study by the Georgia State Department of Education supported this finding and stated that sex-stereotyping (girls not as capable as boys) was a major factor in female mathematics anxiety. Nielsen also attributed female mathematics anxiety to a variety of sexist factors in such areas as curriculum and teacher expectations.

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Authorities agreed that teachers play a key role in the decreasing and alleviating of mathematics anxiety. First and foremost Wagner and Chapline (1981) pointed out the need for teachers, themselves, to be free of mathematics anxiety or to at least have it under control. According to Merchant and Sherard, teachers must also show a real enthusiasm for the subject and have a truly positive attitude towards mathematics.

Wright, Heller, Sachs, Howard, Chapline (1980), and Tobias all recognized the need for math anxiety reduction programs to help teachers overcome and control their mathematics anxiety. Heller recommended the Mathematics Anxiety Reduction Training (MART) program, whereas Howard recommended the use of MICA (Mathematics in Content Areas). Tobias (1976) on the other hand supported the use of math clinics. To help identify the areas in which a person had mathematics anxiety, Richardson propounded the use of the Mathematics Anxiety Rating Scale (MARS).

In the classroom, Lasher, Morris, Widmer, and Sherard indicated that in order to decrease mathematics anxiety, teachers are responsible for creating a positive and supportive atmosphere. In addition, Howard, Sherard, Wagner, and Brush all found that teachers need to stress above all else the relevance of mathematics and according to Tobias (1980), Morris, and Widmer they need to also stress reasoning, problem solving, understanding and spatial skills. Sherard, besides stressing these areas, concurred with Nielsen about the importance of avoiding the sex-role stereotype that math is a male domain.

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To decrease mathematics anxiety once it has been contracted, DeBronac-Mead and Furuto recommended the use of behavior modification combined with remediation. Genshaft suggested the use of self instruction training while Furuto, Gourgey, Sherard, and Stevens advocated reducing mathematics anxiety by improving students' mathematical self concepts. Streim decreased math anxiety through the use of anxiety management training and negative self practice.

Finally, both Lasher and Barrow found that the use of journals or math autobiographies also decreased student mathematics anxiety levels. Lasher and Barrow showed that journals helped students become more in touch with their feelings and allowed teachers to become more in touch with their students.

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CONCLUSION

What is mathematics anxiety?

Mathematics anxiety is a mental, emotional and sometimes physical disorder that can severely handicap the person who contracts it. It is the feeling of tension that limits a person's ability to manipulate numbers and to solve mathematical problems. Mathematics anxiety is a condition that can affect anyone. It does not know social, economic, racial, religious or sexual boundaries. It is a condition that can develop slowly or evolve overnight as the result of a traumatic mathematics experience. It is a very serious problem that impedes learning and inhibits career goals as well as career growth. Those most susceptible are students, especially elementary age students, where teachers have a very significant role in their learning environment.

What causes mathematics anxiety and how is it reinforced?

There exist many causes for mathematics anxiety. In the home, children may inherit a wide range of negative feelings toward mathematics. Often parents, who did not understand mathematics nor its usefulness, will convey this to their children.

In school, children may encounter teachers that are not skillful in math and who, themselves, may suffer from mathematics anxiety. This anxiety is once again passed on to the children almost as if it were contagious. Students may encounter still other sources of mathematics anxiety such as sex-role stereotyping, math mind myths, and other stigmas

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which society has come to accept.

These causes aside, a student still has to content with the math itself. The abstractness, symbolism, and rules of mathematics often can be causes of anxiety themselves, not to mention testing or whatever methods of valuation are used.

There are an abundance of obstacles that cause mathematics anxiety and impede students' progress. These must be confronted and traversed or they can quickly compound themselves and seriously handicap an individual.

Is there hope?

Teachers, the most important part of the learning environment of every student, are the key to the solution of the mathematics anxiety problem. They, especially those in elementary schools, must first cope with, if not completely overcome their anxiety towards mathematics. Clinics, or other mathematics anxiety reduction programs, can help teachers (and others) to overcome their anxieties as well as teach them to help their students cope with their own anxiety. Teachers can better understand math, its importance, and even begin to enjoy math and become enthusiastic about it through these programs.

Once teachers have alleviated their own mathematics anxiety a very big obstacle will have been removed from the students and their anxiety levels will begin to decrease. Teachers can then work to improve their students' mathematics self-concepts and with remediation, successfully help students overcome their fears.

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A much more difficult objective to achieve and one that will require long range plans, is the elimination of society's stigmas and sex-role stereotypes related to math. By starting first with our teachers and our teachers then helping their students we can, however, hope that eventually all obstacles will be removed and students will be able to learn mathematics, anxiety-free.

It is not an easy task before us, but one that will require a great deal of time, effort, and especially commitment. For us as educators to insure that each child has the best chance of success, we must do our best to remove the obstacle of mathematics anxiety. As J. Morris pointed out "...since anxiety is a learned response to a negative experience, it can be prevented." (p.417) It is our responsibility as educators to see that this is done.

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RECOMMENDATIONS

It is recommended that:

1. Educators assume the responsibility and overcome their own mathematics anxiety.
2. Educators accomplish the above by enrolling in a mathematics anxiety reduction program.
3. The relevance of mathematics be emphasized in the classroom.
4. Mathematics be integrated into different subject areas and that teachers become more aware of its uses.
5. Positive, relaxed and supportive classroom atmospheres be provided for the students.
6. Understanding of the thought process as well as development of formal thinking, problem solving, spatial skills, and constructive floundering be stressed.
7. Educators work towards dispelling the 'math mind' myths, sex-role stereotyping, and other stigmas that cause mathematics anxiety.
8. Journals or math autobiographies be used to reduce mathematics anxiety.

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9. Students' mathematics self-concepts be improved.
10. Math anxiety reduction programs be implemented at all educational levels.
11. Educators help students feel that math is enjoyable, valuable and fun.
12. Further research be done in the area of mathematics anxiety to find additional ways of alleviating its symptoms and for the means to avoid generating it, in the first place.

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STUDENT BACKGROUND

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